Deducing the neutron skin thickness in ^{208}Pb from the strength function distribution of the isovector giant dipole resonance

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An accurate knowledge of the density dependence of the symmetry energy coefficient, E_{SYM}, is needed for the equation of state (EOS) of asymmetric nuclear matter (NM). It is well known that the energies of the isovector giant resonances, in particular, the isovector giant dipole resonance (IVGDR), are sensitive to the density dependence of the symmetry energy E_{sym}, commonly parameterized in terms of the quantities J, L and K_{sym} which are the symmetry energy at saturation density of symmetric NM, and the quantities directly related to the derivative and the curvature of $E_{sym}(\rho)$ at the saturation density, respectively. Furthermore, information on the density dependence of E_{SYM} can also be obtained by studying the isotopic dependence of strength functions, such as the difference between the strength functions of ^{40}Ca and ^{48}Ca and between ^{112}Sn and ^{124}Sn. Other physical quantities that are sensitive to the $E_{sym}(\rho)$ below the saturation density are: the neutron skin thickness, r_n - $r_{p,}$ the difference between the root mean square radii (rms) of the neutron and proton density distributions; and the electric dipole polarizability α_D, which is related to the inverse energy moment (m_{-1}) of the strength function of the IVGDR.

Recent high-resolution measurement [1] of α_D in ^{208}Pb was used to determine the value of the neutron skin thickness in this nucleus, resulting in the value of r_n - r_p = 0.156 (.025) fm . However, the analysis in this work was based on only one form of energy density functional (EDF), associated with the Skyrme SV-min interaction. Here we examine the conclusion of the work of Ref. [1]. For this purpose, we have carried out fully self-consistent Hartree-Fock (HF) based RPA calculations of the isovector (*T* = *1*) giant dipole resonance (IVGDR) in ^{208}Pb, using over 27 commonly employed Skyrme type interaction, which were deduced by carrying out HF based fits to wide ranges of experimental data on binding energies and radii.

In Fig. 1 we present the predictions [2] of these interactions for α_D and r_n - r_p. The experimental data on α_D is shown as the region between the dashed lines. Also shown is the Pearson correlation coefficient C_{AB} = 0.55, which indicates a weak correlation between α_D and r_n - r_p. We thus conclude that EDFs associated with theoretical predictions of values of r_n - r_p in the range of 0.14 to 0.20 fm are consistent with the experimental data on α_D.

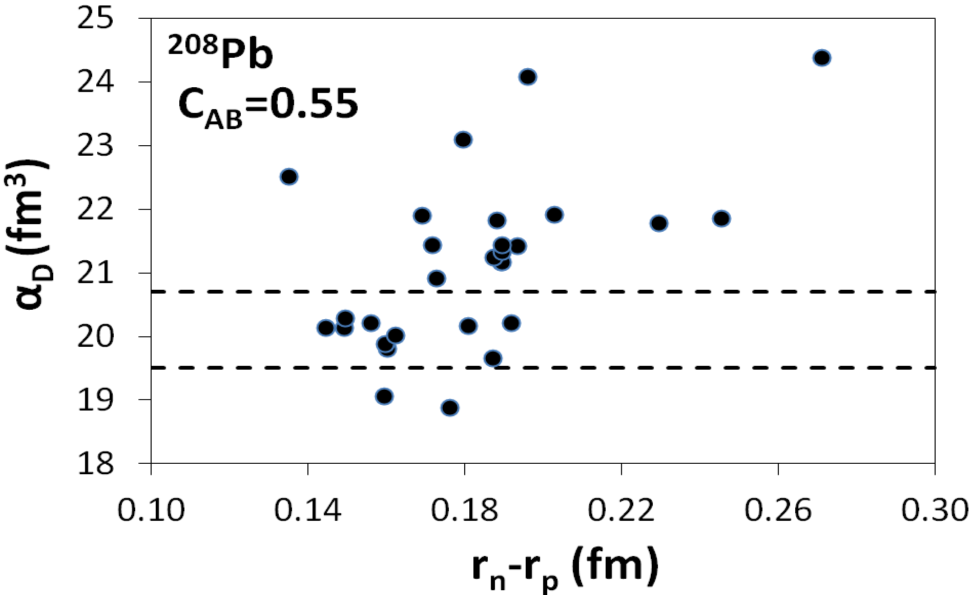

FIG. 1. The IVGDR polarizibilty α_D and the corresponding values of r_n - r_p for various interactions. The experimental data on α_D is shown as the region between the dashed lines.

[1] A. Tamii *et al.*, Phys. Rev. Lett. **107**. 062502 (2011).

[2] M.R. Anders and S. Shlomo, in preparation.